Assessing Performance of an Endophyte-Enhanced Hybrid Poplar Phytoremediation Program for TCE at an Arid, Fractured Bedrock Site

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Background/Objectives. Several areas within a former industrial facility in Southern California are being remediated for volatile organic compounds (VOCs), predominantly trichloroethene (TCE) in groundwater (concentrations up to 22,000 micrograms per liter [µg/L]). Subsurface conditions (decomposed granite and fractured bedrock with low mass flux and permeability) and close proximity to an ephemeral stream exclude remedial technologies used elsewhere at the site; phytoremediation was identified as the primary remedial alternative. In 2016, an approximate 2-acre area was planted with hybrid poplar trees inoculated with a TCE-degrading endophyte to establish the phytoremediation system. Beginning in 2018, evaluation of the phytoremediation system performance began, including assessment of tree growth, tree tissue characteristics (chlorophyll, minerals, VOCs), microbial community composition, and changes in groundwater chemistry. The TCE-degrading endophyte in tree tissues provides a unique metric to evaluate the remedial system performance, specific to biodegradation of TCE. This presentation summarizes the initial performance data, and discusses implications for adjustments to the remedial system.

Approach/Activities. Phytoremediation performance is evaluated using a combination of field observations and laboratory analytical tests. Tree diameter measurements chronicle overall tree growth, and chlorophyll concentrations in leaves correlated with chloride and other key mineral concentrations (nitrogen, phosphorus, potassium) assist in evaluating potential performance inhibiting stress or toxicity. Tree tissue samples from two transects have been analyzed for TCE and its degradation products (cis-1,2-dichloroethene [cis-1,2-DCE], vinyl chloride) during the second and third year of growth, and the results are integrated with semi-annual groundwater monitoring data to evaluate early performance of the phytoremediation system. The results of tree tissue q-PCR for the TCE-degrading endophyte are used to provide evidence that groundwater uptake and phytodegradation of TCE can occur, even in potentially toxic, high concentration environments. Bio-Traps® placed in monitoring wells within the plantation area allow for assessment of changes in the microbiological community composition (including presence of the dehalococcoides (DHC) strain in groundwater) that may result from rhizospheric activity associated with the phytoremediation system.

Results/Lessons Learned. Sustaining a phytoremediation system in an arid bedrock environment is challenging. Successful tree establishment requires attention to irrigation, pest control, and fertilization – several years may pass before the remediation system is mature enough to produce demonstrable results. In the third year at this site, performance monitoring including analysis of tree tissue and groundwater chemistry, and microbiological assessment indicate that uptake of TCE-impacted groundwater has started to occur in portions of the plantation. The first year of performance monitoring results are presented, and modifications to the remediation system based on these data are discussed.